MINI-REVIEW

Risk factors and control strategies for silicotuberculosis as an occupational disease

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Abstract

Silicotuberculosis is critical in community settings among workers and employees exposed to silica dust. Older age of entry (>30 years), male sex, infection with human immunodeficiency virus (HIV), exposure duration, smoking, chronic obstructive pulmonary disease, migration, the severity of the silicosis and the intensity of the exposure are potential risk factors. Lack of timely diagnosis and treatment for tuberculosis (TB) may also raise the rate of infection; previous treatment of TB is possibly associated with the development of silicotuberculosis in more than half of patients, increasing with age (>40 years). Identification of risk factors benefits not only the academic research community, but also the workers or employees and policy making. Some strategies can be implemented, such as controlling or reducing exposure to silica dust, ensuring continuity of treatment of TB or extended anti-TB treatment, management of the situation by occupational health professionals, prevention of oscillating migration, providing workers with compensation, training and education in occupational health, improving the quality of life of miners and workers, intensive medical surveillance and TB screening in routine health check ups, and policy making for higher immunity to inhibit inhalation of dust by workers or employees.

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Context

Silicosis caused by the entry of silica dust into the lungs is a chronic lung disease. Silica is among the predominant minerals in the earth's crust. Workers are predisposed to and are at risk for silicosis when working in jobs where they are exposed to silica particles [1]. Silicosis disease or even exposure to silica without initiating the disease is associated with predisposition or risk of progress in various co-morbidities. Recently, the incidence rate of tuberculosis (TB) has been reported as 1.9% per year [2]. Fortunately, the number of incident cases has been falling annually since 2006 because of reform in population health and the global Stop TB Strategy. Approximately one-eighth of individuals diagnosed were co-infected with human immunodeficiency virus (HIV), among which 82% were in the WHO African Region in 2010 [3]. Furthermore, the disease has a high rate of death among those who work with exposure to dust. Tuberculosis is one of the critical infectious diseases in terms of morbidity and mortality worldwide. There is a close relation between silicosis and TB [6]. The burden of the infection among exposed workers is not known in developing countries because of lack of surveillance and poor access to health services. The risk of silicosis-related TB is 2.8 to 39 times higher than that of the healthy population [3,4]. The pleural (61%) and pericardial forms are the most common signs, followed by the lymph node form [5–7]. The time duration of TB following silicosis might be several years. The silica impairs the activity of alveolar macrophages, and severe exposure leads to macrophage apoptosis [8]. In addition, excessive surfactant

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protein A is associated with higher susceptibility to TB, possibly through the inhibition of the production of reactive nitrogen species by the activated macrophages, leading to the entrance of mycobacteria into the alveolar macrophages without triggering cytotoxicity [9]. Furthermore, *Mycobacterium tuberculosis* can persist, encapsulated within the silicosis nodules; the bacteria can then reactivate in these patients. Silicosis leads to increased risk of lung cancer, autoimmune disorders, mycobacterial infection, airflow obstruction and chronic bronchitis, and to both tuberculous and non-tuberculous mycobacterial infections [10–12]. The disease is diagnosed by observations of respiratory impairment and changes in the chest radiograph.

Tuberculosis is a critical public health problem in the twenty-first century ranking above HIV/AIDS in 2016 [14]; however control programmes have not been successful in its eradication or control in communities with high exposure to silica, where its morbidity and mortality rates are high [15]. Known as fibrogenic lung disease, silicosis is a historical occupational illness with a historical focus of interest in previous centuries. The disease is very important in low-income areas where new cases of silicosis are reported and its reduction needs more time to be achieved. According to recent investigations, the death rates due to TB have been reduced to 1.7 million cases, among which 0·4 million deaths were among people co-infected with HIV, but mostly among adults in East Asia and Africa [2,13]. This study was performed to assess the silicotuberculosis rate, risk factors and prevention strategies.

Silicotuberculosis burden

The problem is that silicosis is not sensed when silica dust enters the body and has slow progressive effects; hence, it is known as a hidden epidemic disease. Although the number of individuals exposed to silica and progressing silicosis who develop silicotuberculosis is not high, the disease is critical in certain communities among workers who lack education and work where safety standards are poor. Most cases of silicotuberculosis are reported as case reports, however, there have been countrywide prevalence assessments. For example, of 16 376 cases of silicosis in Portugal, 205 had silicotuberculosis which was significantly associated with age, sex (male) and pulmonary disease [14]. It has been stated that the rate of the disease is higher in low-income countries because of lower education, lack of preventive equipment and lower adherence to the standard safety rules [15]. In another study in central Iran, of 3121 workers and prevalence of silicosis cases was 917 cases per 100 000 people, which was significantly associated with age, duration (<10 years) of exposure and smoking. The disease case rate is high in Brazil, being significantly higher among dust-exposed individuals cases within a city, but no significant difference was observed between men and women [16]. In Turkey, 19.3% and 99.3% of all individuals with silicotuberculosis had occupational diseases and occupational pulmonary diseases, respectively [17]. Among 376 coal workers in China, 200 (53.1%) were smokers, which was a risk factor for lung impairment and pneumoconiosis [18]. In a study among 250 individuals with pneumoconiosis, the rate of silicotuberculosis was 12.8%—was diagnosed 1.5 ± 0.05 years after the X-ray changes—hence, preventive duration of TB was important for its prognosis [19].

Silicotuberculosis co-infection with HIV

The arrival of HIV has been demonstrated as a risk factor for increase in the silicotuberculosis rate [20–22], although the incidence of this disease has not been related to HIV infection in other studies [23,24]. Furthermore, work in mines and migration have increased the incidence of HIV infection during recent years. It seems that testing for HIV should be performed in miners and sandblasting workers in addition to tests for silicotuberculosis.

Risk factors for silicotuberculosis

Although exposure to crystalline silica and sandblasting are the major risk factors for the development of silicotuberculosis (2.8 to 39 times higher than normal conditions), several other risk factors may participate in this condition. As mentioned previously, older age of entry (>30 years), male sex, infection with HIV, employment and exposure duration, smoking, chronic obstructive pulmonary disease, migration, the severity of the silicosis, exposure to toxic materials and the intensity of the exposure are potential risk factors [25–27]. Risk factors at the individual level have not been determined for better understanding of disease progress and its control [16]. Lack of timely diagnosis and treatment for TB may also raise the rate of infection; however, previous treatment of TB may be associated with the development of silicotuberculosis in more than half of patients, increasing with age (>40 years) [28,29]. Those patients with asthma should also be examined in case of infection. Local immunity impairment within lungs might be another predisposing factor. Identification of risk factors benefits not only the academic research community, but also the workers or employees and policy making [30].

Future insights and conclusion

Silicotuberculosis is an important disease worldwide that needs specific attention [31,32]. Some strategies can be implemented, including controlling or reducing exposure to silica dust, ensuring continuity of treatment of TB or extended anti-TB treatment, management of the situation by occupational health professionals, prevention of oscillating migration, providing workers with compensation, training and education in occupational health, improving the quality of life of miners and workers, intensive medical surveillance and TB screening in routine health check ups, and proper policy making to inhibit inhalation of dust by workers or employees, to decrease the rate of silicotuberculosis.

Transparency declaration

The authors have no conflicts of interest to declare.

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